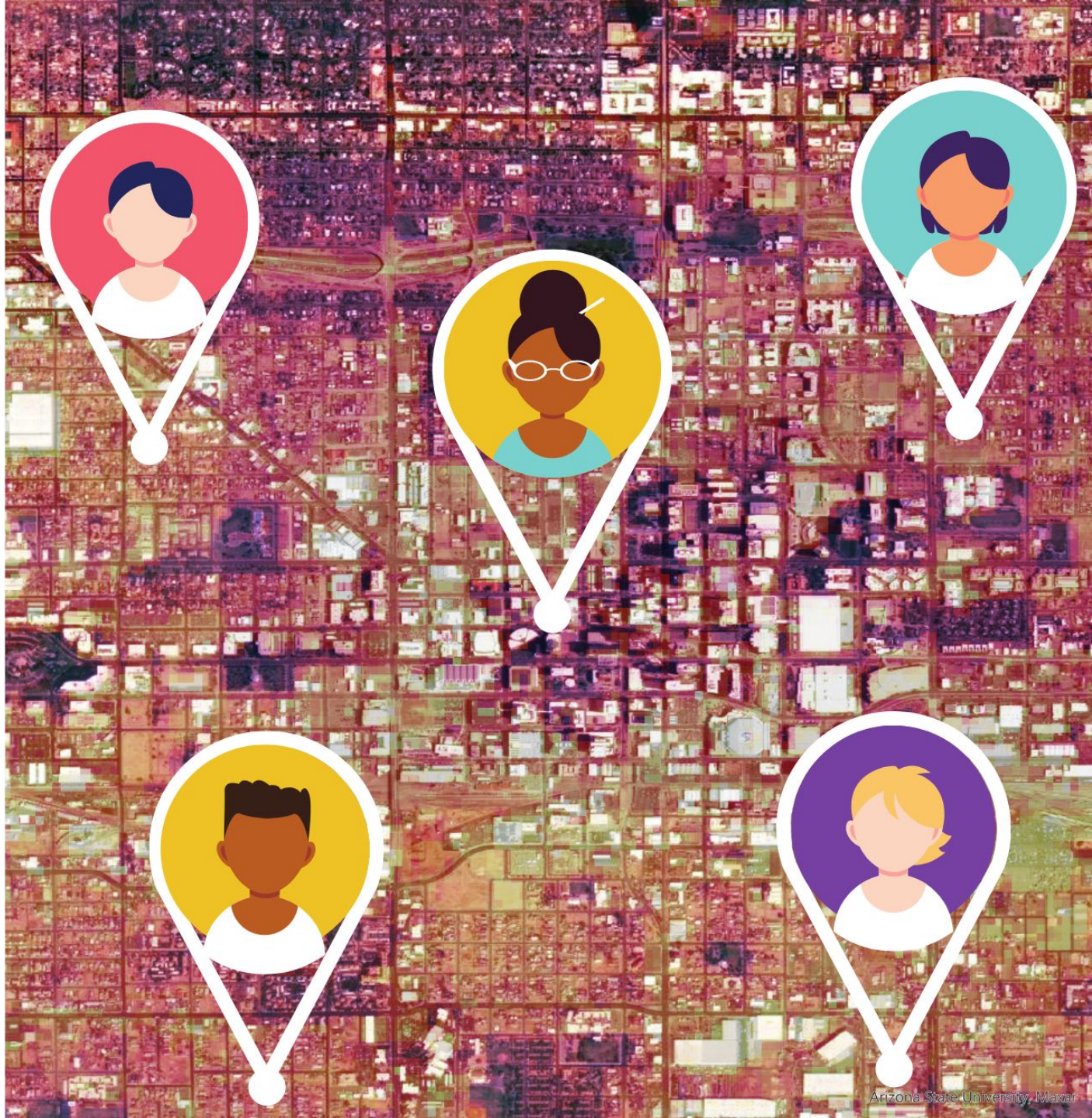
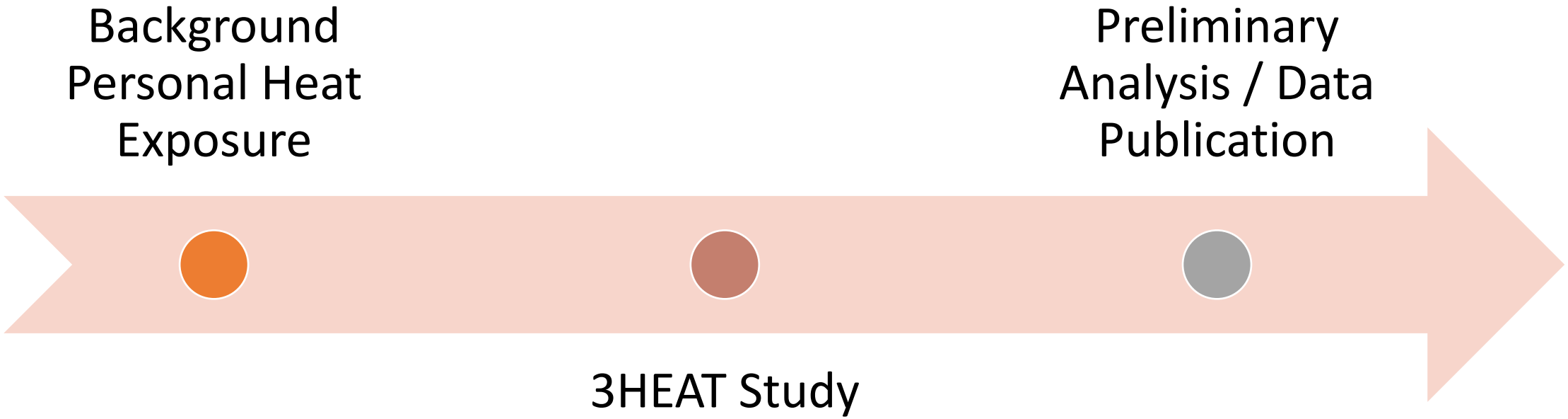
Personal Heat Exposure

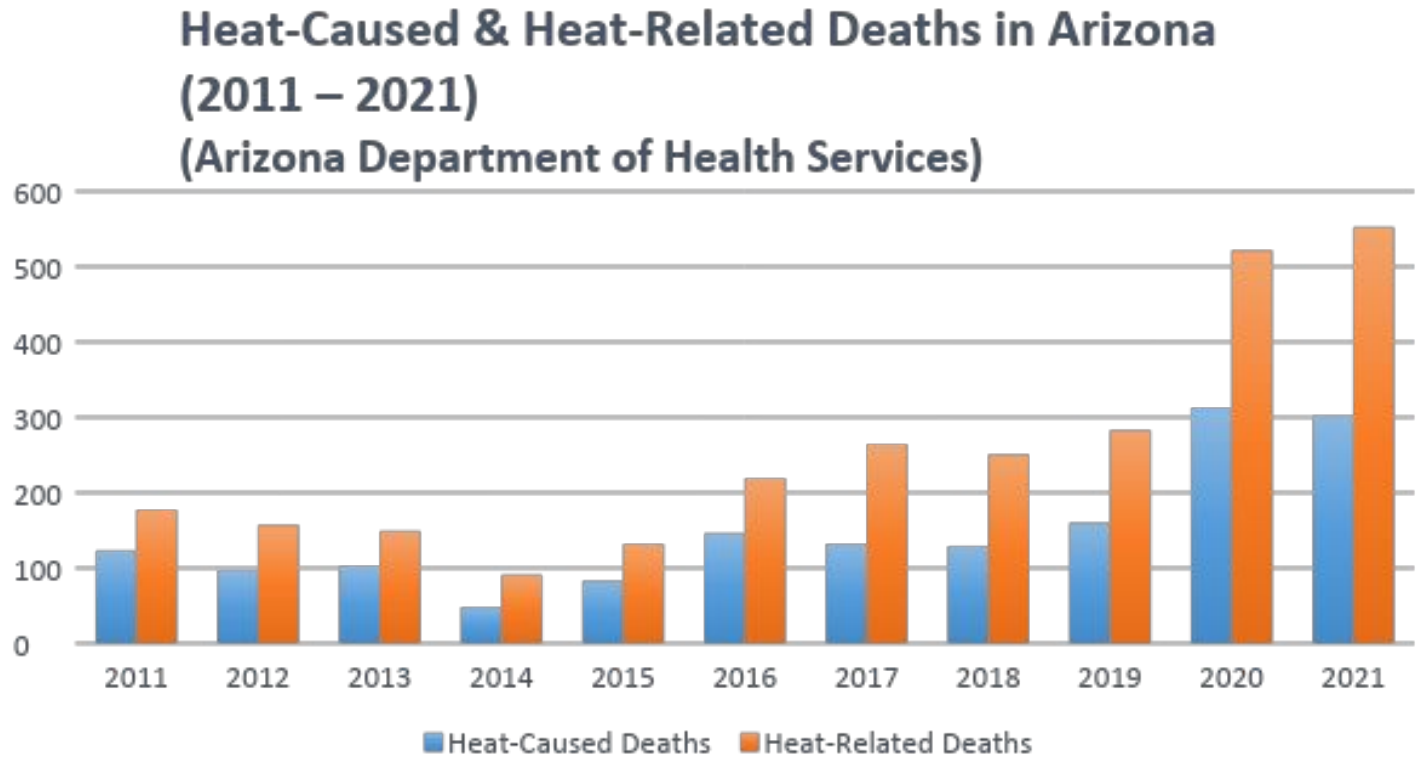


Webinar Overview



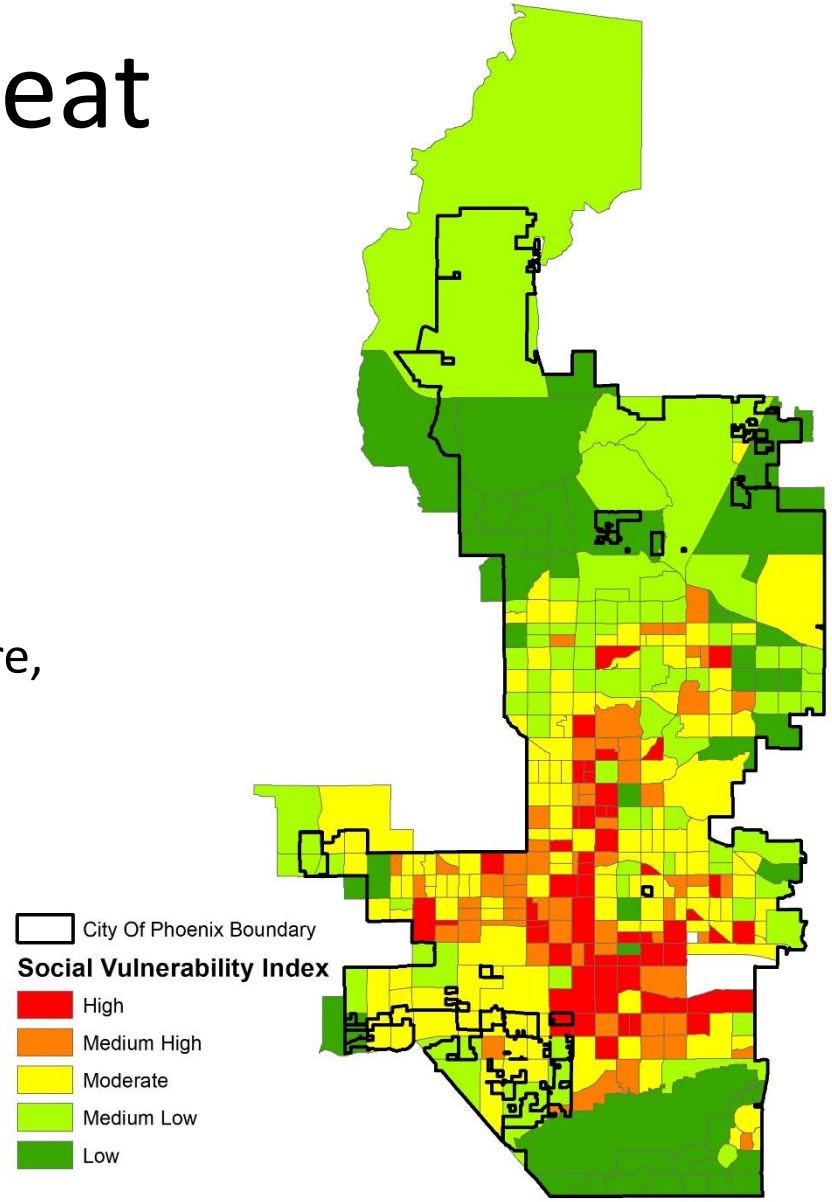
Public Health Implications of Extreme Heat

- Extreme temperatures one of the leading weather-related causes of death in the US
- Extreme heat can affect the body's ability to regulate temperature, which can result in heat cramps, heat exhaustion, heatstroke, and hyperthermia.
- Extreme heat can also exacerbate chronic health conditions like cardiovascular, respiratory, cerebrovascular disease and diabetes (USGCRP, 2016)



Social Vulnerability to Extreme Heat

- Vulnerability Framework:
  - Adaptive Resources, Sensitivity, Exposure
- How do we tend to operationalize vulnerability?
  - Vulnerability Index
    - Input Data: sociodemographic, land cover/ land use, temperature, vegetation prevalence, health status
- Limitation of Indices
  - Vulnerability is a processes and not directly measurable
  - Incorporates very few proximate variables related to adaptive resources and sensitives



Social vulnerability index for Phoenix, AZ

What is Personal Heat Exposure

- Personal Heat Exposure:

  "We define **personal heat exposure as realized contact between a human and an indoor or outdoor environment** in which the air temperature, radiative load, atmospheric moisture content, and air velocity collectively pose a risk of increase in body core temperature, perceived discomfort, or both." – Kuras et al (2017)

ibutton temperature and humidity sensor

HOBO Pendant temperature / light sensor

Kestrel Drop temperature, humidity, and pressure sensor

Importance of Personal Heat Exposure

- Fixed-point weather stations are not very useful for approximating personal exposure (Hondula et al, 2021; Sugg et al, 2019; Martines-Nicolas et al, 2015; Kuras et al, 2015; Sugg et al, 2018)
- Better understand pathways that lead to heat-related illness
- Improved siting for changes to the outdoor environment (e.g. tree canopy cover)
- Useful for interventions that don't focus on changing outdoor temperature (e.g. indoor temperature)
  - On average Americans spend between 80% and 90% of their time indoors (Klepeis et al., 2001)

3HEAT Overview

- Three City Heat and Electrical Failure Adaptation Study (3HEAT)
- Study Area: Phoenix, AZ, Detroit, MI, and Atlanta, GA
- Objective: investigates the social, environmental, and technological adaptations that affect health outcomes due to independent or coupled heat and power failure events

3HEAT Research Team

Phoenix – 3HEAT Data Collection

Phase 1

- Stratified random sample
- 163 door-to-door surveys
- Typical Survey Time: 20 mins
- Response Rate: 30%

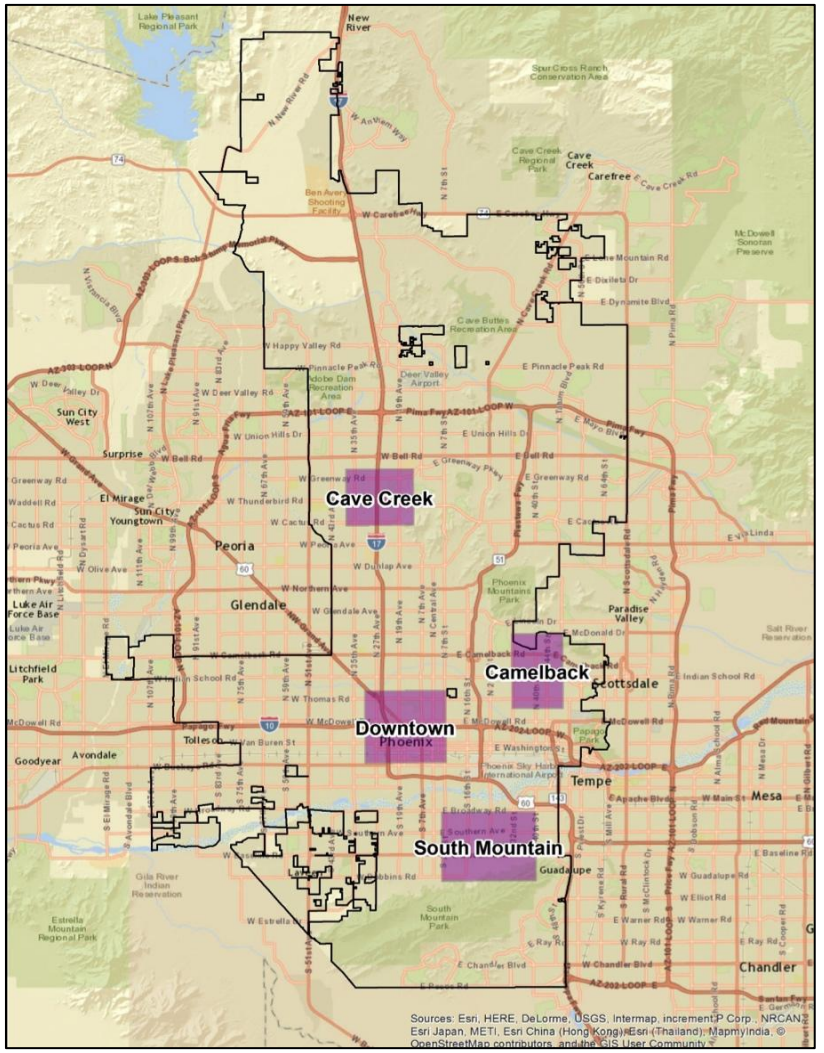
Asking residents about:

1. *Access to and use of cooling resources*
2. *Constraints on cooling resources*
3. *Thermal preference*
4. *Demographics*
5. *Energy use*
6. *Prior experience with extreme heat*

Phase 2

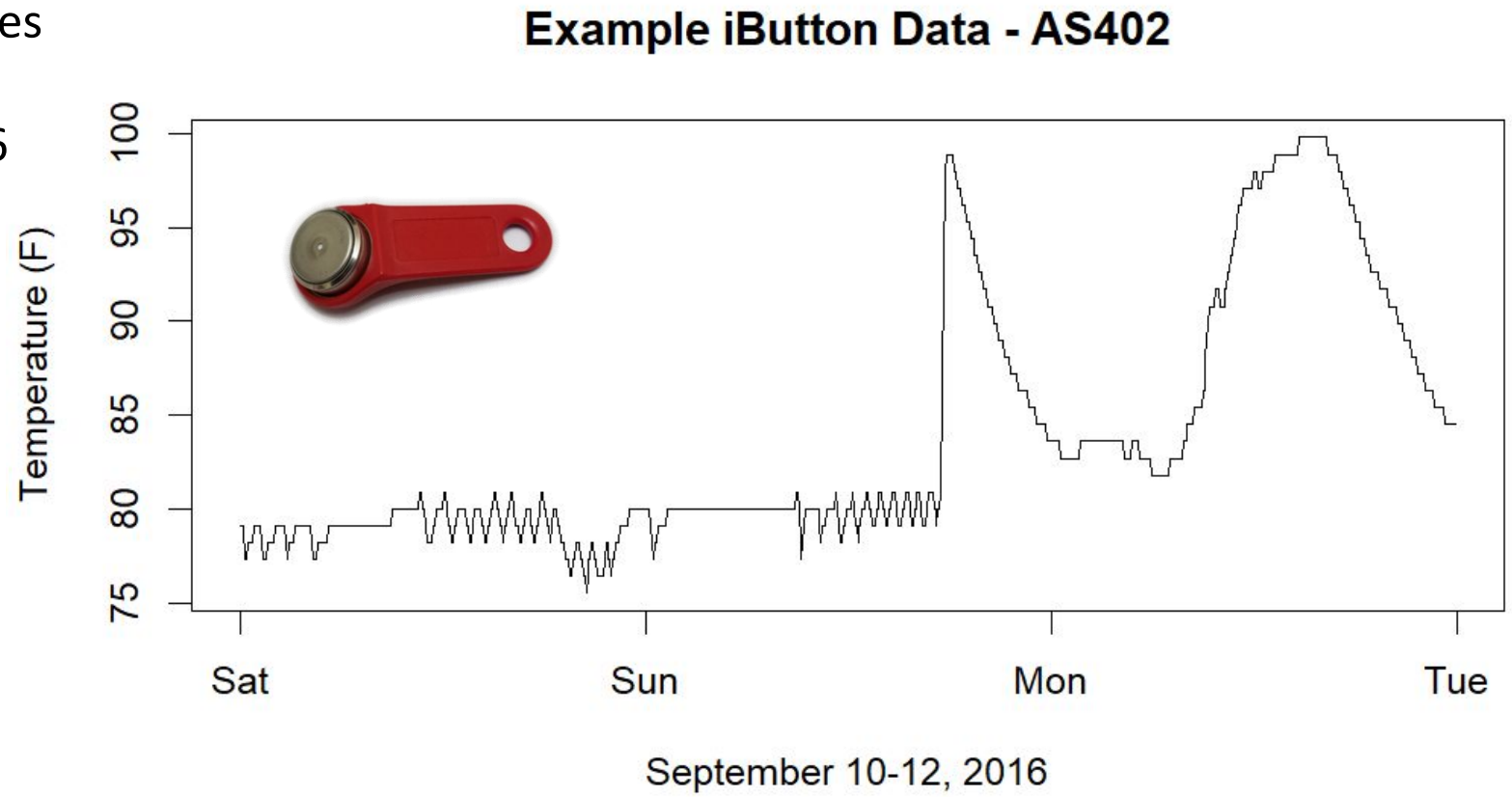
- 55 participants (subset of 163 Phoenicians surveyed for 3HEAT project).
- August 21 – September 19, 2016
- Monitored indoor, outdoor, and personal temperature exposure

Study Area: Phoenix, AZ



Personal Temperature Exposure Data – iButton

- Hygrochron Temperature and Humidity iButtons (Model DS 1923-F5#, accuracy +/- 0.5°C
- Wore iButtons on the outside of their clothing
- Sampling temperature every 5 minutes
- Total number of observations = 1,966



Personal Temperature Exposure Data – Time Activity Diary (TAD)

LOCATION
Set of categories of indoor and outdoor locations

ACTIVITY LEVEL
Four point scale from 1 (sitting or lying down) to 4 (heavy exertion, can't have conversation)

THERMAL SENSATION
Nine point scale from -4 (very cold) to 4 (very hot)

COOLING METHODS
Twelve unique cooling methods. Participants could list any they used in a given time period

Date: 5/25/2016

Time of Day	Location	Activity Level(s)	Cooling Method(s)	Thermal Sensation(s)	Had i-Button
	Indoor 1 = home 2 = friend's or relative's home 3 = indoor workplace 4 = store 5 = bar/restaurant 6 = office (e.g., doctor, etc.) 7 = library 8 = school/college 9 = senior or rec center 10 = gym 11 = museum 12 = movie theater 13 = casino 14 = cooling center 15 = church/house of worship **Outdoor** 16 = car 17 = bus/train 18 = bike 19 = motorcycle/scooter 20 = outdoor workplace 21 = yard 22 = sidewalk 23 = parking lot 24 = park 25 = pool/beach/splash pad **30 = traveled outside the city** **31 = traveled outside the metro area**	1 = sitting or lying down 2 = light exertion (breathing easy) 3 = moderate exertion (breathing harder) 4 = heavy exertion (can't have conversation)	**0 = none** **Indoor** 1 = air conditioning 2 = evaporative (swamp) cooler 3 = window/ ceiling fan 4 = open windows 5 = go to basement 6 = cool shower/ bath **Outdoor** 7 = go in the shade 8 = mister/ sprinkler 9 = swimming or boating **Any Location** 10 = remove/ change clothes 11= drink cool beverage 12 = cool skin with water or compress	-4 = very cold -3 = cold -2 = cool -1 = slightly cool 0 = neutral 1 = slightly warm 2 = warm 3 = hot 4 = very hot	Y/N
SAMPLE BELOW	SAMPLE BELOW	SAMPLE BELOW	SAMPLE BELOW	SAMPLE BELOW	
5-6:29 am	1	(1) 2 3 4	3, 4	-4 -3 -2 -1 0 (1) 2 3 4	Y
6:30-7:07	22	1 (2) (3) 4	0	-4 -3 -2 -1 0 (1) (2) (3) 4	Y
7:08-8:20	1	1 (2) 3 4	3, 4, 6	-4 -3 -2 -1 (0) (1) 2 3 4	Y
8:21-9:17	16	(1) (2) 3 4	1, 3, 4	-4 -3 -2 -1 0 (1) 2 3 4	Y
9:18-9:25	17	(1) 2 3 4	1	-4 -3 -2 -1 0 1 (2) 3 4	Y

Correlations between iButton and TAD

AL_mean: Average Activity Level

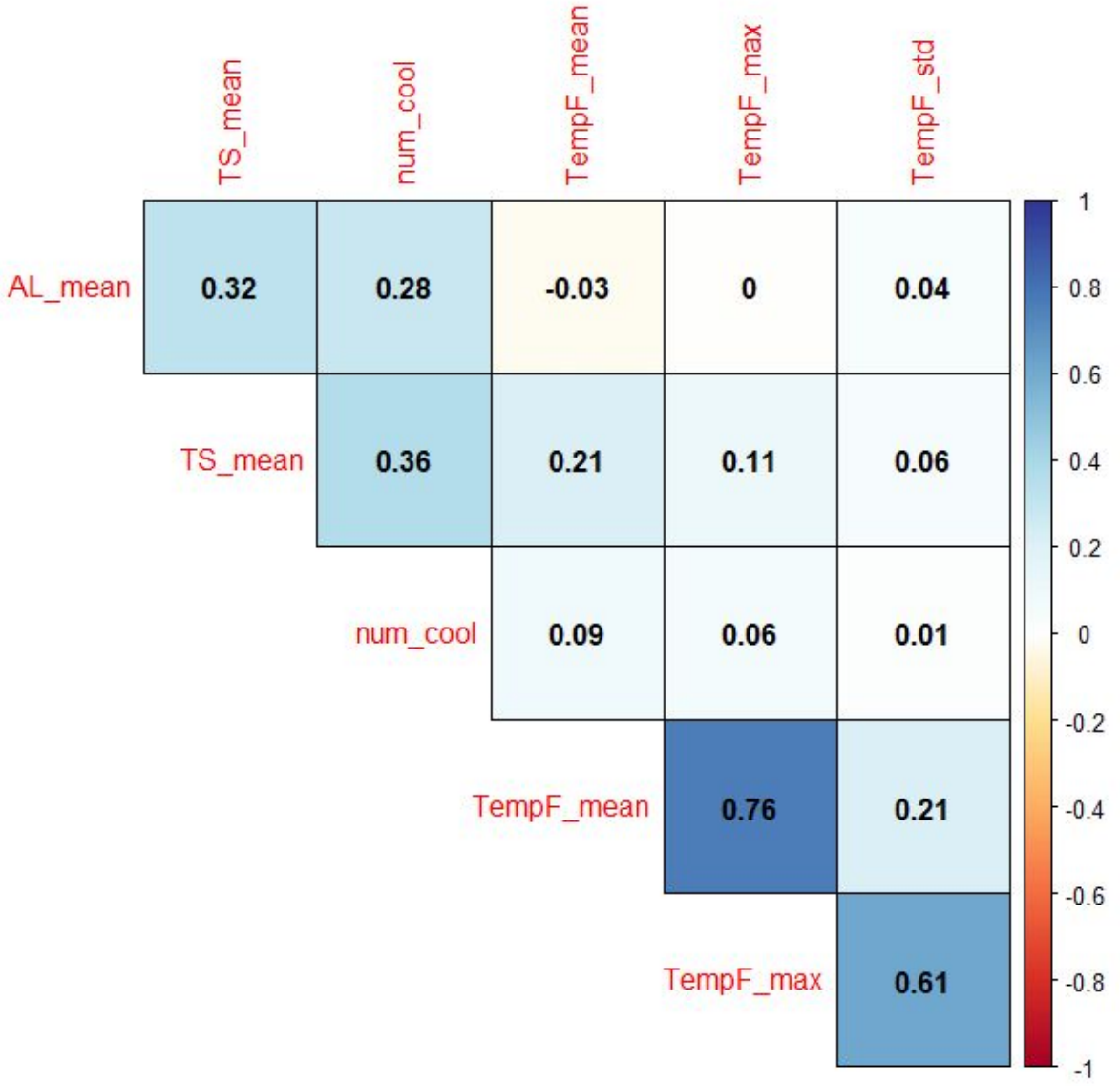
TS_mean: Average Thermal Sensation

Num_cool: Number of cooling behaviors engaged in

TempF_mean: Average Temperature (°F)

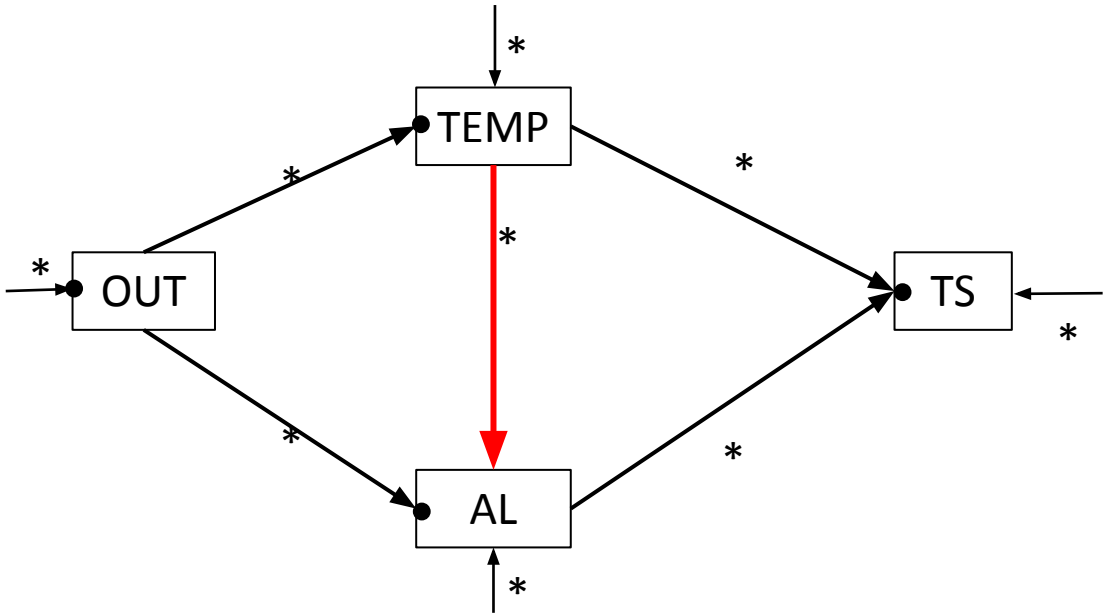
TempF_max: Maximum Temperature (°F)

TempF_std: Standard Deviation in Temperature (°F)

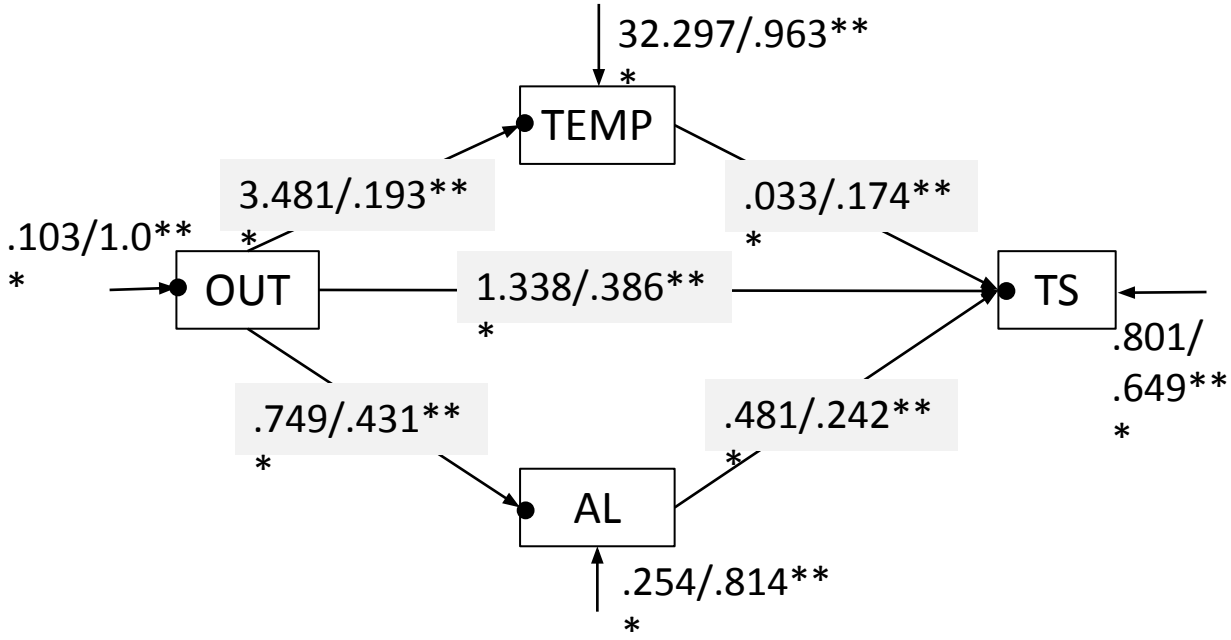


Path Analysis - iButton and TAD

Initial Hypothesized Model



Final Hypothesized Model



Unstd/Std; *$p < .05$, **$p < .01$, ***$p < .001$

designsafe-ci.org/data/browser/public/designsafe.storage.published/PRJ-3324

Workspace | Learning Center | NHERI Facilities | NHERI Community | News | Help | Search DesignSafe

DATA DEPOT

Add

- Published
- Published (NEES)
- Community Data

Help

Find in this Dataset

Rename | Move | Copy | Preview | Preview Images | Download | Move to Trash

PRJ-3324 | Personal Heat Exposure

https://www.designsafe-ci.org/data/browser/public/

Download Dataset

PI	Watkins, Lance
Project Type	**Field Research | Social Sciences**
Natural Hazard Type	**Other**
Event	**Extreme Heat | Phoenix, Arizona | 08-07-2016 — 09-23-2016 | Lat 33.448 Long -112.074**
Awards	**National Science Foundation SEES-Hazard - NSF SES-1520803**
DOI(s) in Project	10.17603/ds2-c3q7-vv73 10.17603/ds2-c5db-q090 10.17603/ds2-rakj-a122
Keywords	**3HEAT; Personal Heat Exposure**

View Data Diagram | View Project Metrics | Leave Feedback

Description | This project was a component of the larger NSF funded Three City Heat and Electrical Failure AdapTation (3HEAT) Study, which aimed to assess the health impact of a simultaneous city-wide power outage and heatwave in the cities of Phoenix, Arizona; Detroit, Michigan; and Atlanta, Georgia. This subset of the larger 3HEAT project aimed to measure the personal heat exposure of Phoenix residents. Additionally we related residents' personal heat exposure profiles to their daily activities, cooling methods, and thermal comfort. The data from this project could be reused to better…
Show More

PRJ-3324

- Documents | **Time-Activity Diary Instrument**
- Documents | **iButton Instrument**
- Mission | **Hygrochron Temperature and Humidity iButton and Time Activity Diary - Wave 1**

Acknowledgements

- Natural Hazards Center Weather Ready Research Award Program
- National Oceanic and Atmospheric Administration(NOAA)
- CONVERGE + DesignSafe Training
- NSF Hazards SEES Award Number 1520803
- ASU team: Drs. Sharon Harlan, Matei Georgescu, and David Hondula, with Lance Watkins, Liza Kurtz, and Mary Wright.
- University of Michigan 3HEAT team: Drs. Marie O'Neill, Carina Gronlund, Larissa Larsen, and students and staff
- Georgia Tech 3HEAT team: Dr. Brian Stone, Dr. Fried Augenbroe, and students and staff
- The Urban Climate Research Center at ASU (urbanclimate.asu.edu)

Lance Watkins: lewatkin@asu.edu